Correlates of *Cryptosporidium* spp and *Giardia* spp contamination in improved drinking water sources in rural India: implications for universal access to improved sanitation and safe drinking water

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Abstract

Background As part of the Total Sanitation Campaign (1999–2012), the Indian Government promoted construction and use of tens of millions of household latrines to improve public health in rural communities, areas where tubewells are often the main source of drinking water. In this study, we aimed to identify causes of tubewell contamination with the protozoal diarrhoeal pathogens, *Cryptosporidium* spp and *Giardia* spp in a coastal area in Puri District, Odisha, India.

Methods We used data from a large-scale cluster randomised controlled trial of health effects of improved household sanitation in Puri District, gathered in 60 villages during the 2012 and 2013 monsoon seasons from June to August. We used multivariable modelling to identify associations between *Cryptosporidium* spp and *Giardia* spp contamination and variables such as tubewell characteristics, village socioeconomic characteristics, spatial densities of human and livestock faecal sources around each tubewell including leaching from latrine pits and cowsheds, and meteorological conditions.

Findings We included data for 107 deep public and 96 shallow private tubewells of which 36 (18%) were contaminated. We found strong evidence that latrines were the source of contamination of local shallow groundwater used for drinking. Each 10 additional person-years of latrine loading, within 10–15 m of a shallow tubewell increased the odds of *Cryptosporidium* spp and *Giardia* spp detection by 21% (OR 1·21, 95% CI 1·06–1·38) and 44% (1·44, 1·12–1·85), respectively. For deep groundwater, the risk of latrine contamination was raised by 1% if the latrines were situated within 150m for *Giardia* or within 500 m for *Cryptosporidium* of a deep tubewell (OR 1·01, 95% CI 0·998–1·012, and 1·01, 1·000–1·027, respectively). In deep tubewells, both protozoa were more often detected when the well pad was cracked or missing than when intact (OR 7·10, 95% CI 1·92–20·57 for *Cryptosporidium*; 5·91, 1·18–29·60 for *Giardia*). For every three goats in a village, we noted an increased OR of 1·09 (95% CI 1·03–1·14) for *Cryptosporidium* spp contamination in shallow tubewells. Antecedent rainfall also showed important mediating effects on contamination in shallow tubewells, depending on protozoan species and rainfall mechanism.

Interpretation The promotion of latrines to increase the proportion of the population using an improved sanitation facility (MDG 7.9) might increase *Cryptosporidium* spp and *Giardia* spp contamination in groundwater drinking sources, especially shallow groundwater. If health gains are to be achieved from improved sanitation for all (SDG 6.2), piped supplies of centrally treated water might need to replace local groundwater drinking sources in settings which are vulnerable to faecal contamination from latrines

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Declaration of interests
We declare no competing interests.